International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-10, August 2019

Testing the Sensitivity and Specificity of ICU Patients and Diagnose Statistics Hypothetical Errors

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Abstract*: *Statistical performance especially for certain information based on data analyse and incorporate clinical trial incomplete observation. The handling statistical hypothesis measure to regulate, type one error and type two errors is related to the assessment of sensitivity and specificity in clinical trial test and experimental data. A theoretical concept is considered two types of errors has been made and measure to find out of False positive, False Negative, True Positive and True Negative. The study presumed to analyse the ICU patient's condition based on who have admitted in elective or emergency. We are conclude that there is association between types of admission and patient's status.

Keywords: sensitivity, specificity, Type I and Type II error, chi-square Test, ICU Patients.

I. INTRODUCTION

The main objective of medicinal investigation is to compare the efficiency of diagnostic tests. Diagnostic test is helpful for clinicians to monitor the diseases, and statistical interpretation concepts also very useful in Hypothetical test. Many researchers [1]-[7] compare the diagnostic tests for the identical observation. A 2x 2 contingency table is an essential part for calculation of diagnostic test and statistical analysis. Testing sensitivity and specificity show a leading role in theoretical approach or practical approach. Bennet [8] discussed on Sensitivity, Specificity in Analytic Processes. Gaddis [9] presented the components of diagnostic testing theory, containing sensitivity, specificity, and predictive value. Emmanuel de et al., [10] deliberated the sensitivity and specificity Analysis Relation to Statistical Hypothesis Testing and its Errors. Wen Zhu et al., [11] studied the concepts of sensitivity, specificity and accuracy in the situation of infection diagnosis. Robert Trevethan [12] presented the Sensitivity, Specificity, Predictive Values and numerous facts of pliability. In this paper will focus on testing the sensitivity and specificity for ICU patients and analyse the ICU patient's condition based on who have admitted in elective or emergency then interpreting the results of sensitivity, specificity and ended by final conclusion of the paper. Gogtay and Thatteby [13] considered the Statistical Evaluation of Diagnostic Tests by the metrics of sensitivity and specificity.

Manuscript published on 30 August 2019.
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II. SENSITIVITY AND SPECIFICITY

Primarily, definition of sensitivity is the probability determining the possibility for a test to pick up the presence of a disease/pathogen, alternatively, a true positive is recorded when a procedure reflects the presence of pathogen in a contaminated sample. Furthermore, we define specificity as the probability of determining the possibility for the absence of pathogen in a not contaminated sample.

III. DATA SOURCE

We are collecting the data source from online. The data type is based on secondary data and medical concepts case study. The study conducted from Baystate Medical center in Springfield, Masschusetts. They are considered 200 patients for observation in the study period in our hospital. However, in this study the patient was analysed 20 variables but we are focused only main variables like age, status, gender, service at ICU admission, heart rate at ICU admission, previous admission to an ICU within 6 months and type of admission.

A. Mathematical concept to types of admission (ICU Patients)

According that the Neyman-Pearson discovered the Type I error is considered the probability of α is called significance level and the Type II error may be occur within a probability is called β. When the probability of rejecting a null hypothesis is indeed false is called power of test 1- β.
In this paper, we discussed how to apply sensitivity and specificity problem conclude in heart rate at ICU admission (beats/min). We are taken decision from heart related disease data when the patients are admitting in ICU. Whoever the patient at the time of admission in ICU, there are two types one is called elective and denote the code is 0 and another one is called emergency is stand for 1. The both are two variables are status (0-Live-Positive result and 1-Death-Negative result) then the types of admission (0-Elective-Present and 1-emergency-Absent) find out sensitivity and specificity models.

$$\text{Sensitivity} = \frac{True\ Positives}{True\ Positives + False\ Negatives}$$

$$\text{Specificity} = \frac{True\ Negatives}{True\ Negatives + False\ Positives}$$

False Positive rate (α)

$$\alpha = \frac{\text{False Positive}}{False\ Positives + True\ Negatives}$$

= 1- Specificity

False Negative rate (β), β

$$= \frac{(Alive + Emergency)}{(Alive + Emergency) + (Death + Emergency)}$$

= 1- Sensitivity

Power= 1- β = Sensitivity

Positive Predicted Value (PPV)

$$PPV = \frac{True\ Positives}{True\ Positives + False\ Positive}$$

Negative Predicted Value (NPV)

$$NPV = \frac{True\ Negative}{True\ Negative + False\ Negative}$$

Model for our data

$$\text{Sensitivity (ICU)} = \frac{(Death + Emergency)}{(Death + Emergency) + (Alive + Emergency)}$$

$$\text{Specificity (ICU)} = \frac{(Alive + Elective)}{(Alive + Elective) + (Death + Elective)}$$

False Positive rate (α)

$$\alpha = \frac{(Death + Elective)}{(Death + Elective) + (Alive + Elective)}$$

False Negative rate (β)

$$\beta = \frac{(Alive + Emergency)}{(Alive + Emergency) + (Death + Emergency)}$$

Positive Predicted Value (PPV)

$$PPV = \frac{(Death + Emergency)}{(Death + Emergency) + (Death + Elective)}$$

Negative Predicted Value (NPV)

$$NPV = \frac{(Alive + Elective)}{(Alive + Elective) + (Alive + Emergency)}$$

Sensitivity

The probability of death the patient in either types of admission or service at ICU admission. It is may be called as the probability of testing positively.

Specificity

The probability of alive the patient at the time of service at ICU admission and the types of ICU admission. In another way can we called as the probability of testing negatively.

Inter Relationship between FPR, FNR, Type I Error, Type II Error and Power of the Test

Type I Error:

α = Type I Error or False positive rate
α = 1- Specificity
α = 1-0.7410
= 0.2585
FPR = 0.2585 = α

Type II Error:

β = Type II Error or False Negative rate
β = 1 - Sensitivity
β = 1-0.0377
= 0.9622
FNR = 0.9622 = β

Power of the Test:

$1-\beta$ = Sensitivity
Sensitivity = $1-\beta$
= 1- 0.9622
= 0.0377
Sensitivity = 0.037

		Types of ICU admission	
Status Results		Emergency	Elective
	Death	Death+ Emergency True Positive	Death + Elective False Positive **(Type I Error)**
	Alive	Alive+ Emergency False Negative **(Type II Error)**	Alive + Elective True Negative

Table 1: Relationship between in Hypothetical Error, Sensitivity and Specificity

		Types of ICU admission		Total
Status Results		Emergency	Elective	
	Death	2	38	40
	Alive	51	109	160
	Total	53	147	20

Table 2: Result for Types of admissions ICU in Heart Patients and Status of Patients

Retrieval Number: J91970881019/19©BEIESP
DOI: 10.35940/ijitee.J9197.0881019
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

	Service at ICU admission		Total
Status Results	Death	Surgical	Medical
	14	26	40
Alive	93	67	160
Total	127	93	200

Table 3: Result for Service at ICU Admission and Patients Status

	Types of Admission	Service at ICU Admission
Sensitivity	0.0377	0.1308
Specificity	0.7410	0.7204
False Positive rate	0.2585	0.2795
False Negative rate	0.9622	0.8691
Positive Predicted Value	0.0500	0.3500
Negative Predicted Value	0.6812	0.4187

Table 4: Sensitivity and Specificity Results for ICU Patients

As per the sensitivity and specificity general thump rule of, the high false negative rate and low false positive rate, that means decrease the sensitivity value and increase the specificity value. But, we are exposed [12] the particular experiment with a specific frame the rule does not naturally express an overall efficiency of the pathogen detection procedure unless it is related to a gold standard. In this research, sensitivity and specificity there are properties for implies a degree of reliability diagnosis or experiment test and do not predict the exactly predicted value, so we conclude increasing the specificity and decreasing the sensitivity it is make decreasing the death at the time of service at ICU admission and types of admission.

Null Hypothesis

H_o: There is no association between types of admission in ICU and the status of patients.

H_1: There is association between types of admission in ICU and the status of patients

Status	Types of Admission		Total	χ^2 Result
	Emergency	Elective		
Death	2	38	40	**χ^2= 11.866, P = 0.001 Highly Significant**
Alive	51	109	160	
Total	59	147	200	

Table 5: The Chi-Square test for types of admission and status of patients

The above table shows that there is an association between both the variables. We conclude that the Pearson Chi-Square test at 5% level of significance the P value 0.001 is less than 0.05. So, the alternative hypothesis is accepted. In other words, it is highly significant. Hence, there is association between types of admission in ICU is considered as elective, emergency and the status of patients is to be death and alive.

Null Hypothesis

H_o: There is no association between service at ICU admission and the status of patients.

H_1: There is association between service at ICU admission and the status of patients.

Table 6: The Chi-Square test for service at ICU admission and status of patients

Status	Service at ICU Admission		Total	χ^2 Result
	Medical	Surgical		
Death	26	14	40	χ^2= 6.876, P = 0.009
Alive	67	93	160	
Total	93	107	200	Significant

We get the result from the table no., there is association between two variables. The conclusion based on probability value and the level of significance. We exploring the Pearson Chi-Square test at 5% level of significance, the P value is 0.009 is less than 0.05. However, we do not reject the alternative hypothesis. The result shows that highly significant. We are inferring, there is association between the service at ICU admission is denoted as medical, surgical and the status of patients is death and alive.

IV. CONCLUSION

The Statistics hypothetical type I error leads to false positive rate (α) and type II error represent as false negative rate (β). In general, a true positive result death of the patient and true negative considered as alive of the ICU patient at the time of service. We denoted as α =Death +Elective and β = Alive +Emergency. The inferential value get from the table (4) is false positive rate 0.2585 (Type I Error) and false negative rate is 0.9622 (Type II Error). It should be noted that in experimental study, a low false positive rate leads to a low probability of type I Error otherwise type II error. The measuring of sensitivity and specificity, the false negative rate going to increase, this means the test is going to be more specific but less sensitive. The expressed more false positive and less false negative is going to increase the sensitivity and decrease the specificity. In case, we have to 50% of sensitivity and 0% of specificity is called perfectly sensitivity. According, in this research work we find out the sensitivity value is 0.0377 and the specificity value is 0.7410. We are concluding sensitivity and specificity method the value is taken from the table and is identified specificity value is greater than compare to the sensitivity value. Finally, the research outcome convey to less sensitivity value, which means the death rate is very low, the patients status and to compare the types of admission, at the time of service ICU admission of patients.

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